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EXAMINER

BROCK II, PAUL E

ART UNIT

PAPER NUMBER

2815

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/736,724

Applicant(s)

YAMAZAKI ET AL.

Examiner

Paul E Brock II

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 04 November 2002.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-73 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 3-6, 11, 12, 15-17, 65-67 and 72 is/are allowed.
- 6) ☒ Claim(s) 1, 2, 7-10, 13, 14, 18-64, 68-71 and 73 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 13 December 2000 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☒ Certified copies of the priority documents have been received in Application No. 08/912,979.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Claim Objections

1. Claims 24, 30, 37, 38, 44, and 57 – 59 are objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. The subject matter of the noted claims do not further limit their respective parent claim and only serve to confuse the issue of what actually is being claimed.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.
3. Claims 1, 2, 9, 10, 20 – 23, 25, 27, 29 – 33, 35 – 64, 68, and 70 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.
4. With regard to claims 1 and 9, it is not clear how an impurity region is formed by introducing an impurity into the impurity region. Is an impurity already there before the first

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impurity is introduced? For purposes of this office action “a first impurity into said impurity region” will be considered -- a first impurity into said channel forming region --.

5. Further with regard to claims 1 and 9, it is not clear how to interpret “said impurity regions” while only a single impurity region has been defined. For purposes of this office action “wherein said impurity regions have” will be considered -- wherein said impurity region has --.

6. With regard to claims 20 and 23, it is not clear how to interpret “said impurity regions” while only a single impurity region has been defined. For purposes of this office action “wherein said impurity regions have” will be considered -- wherein said impurity region has --.

7. With regard to claims 25, 27, 29 – 33, 35, 37 – 40, 42, 44 – 47, 49, 51 – 54, 56, 58 – 61, and 63, there is no antecedent basis for “said impurity regions”. Therefore, it is not clear how to interpret “said impurity regions” while only a single impurity region has been defined. For purposes of this office action “said impurity regions” will be considered -- said impurity region -. It should be noted that other grammatical errors might need to be corrected in some of these claims while substituting “said impurity region”.

8. Claim 36 recites the limitation "said impurity elements" in the first and second lines of the claim. There is insufficient antecedent basis for this limitation in the claim. For purposes of this office action “said impurity elements” will be considered -- impurity element for forming said impurity region --.

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9. Claims 43, 50, 57, 64 recites the limitation "said impurity elements" in the first and second lines of the claim. There is insufficient antecedent basis for this limitation in the claim. For purposes of this office action "said impurity elements" will be considered -- said impurity element --.

10. It is not clear in claims 20 – 23 how the impurity region is formed. Is the recitation of "wherein an impurity element that expand an energy band width is added to said impurity region," defining the addition of a second impurity into the impurity region? How many impurities are added to form the impurity region?

11. It should be noted that similar inconsistencies similar to the above examples in paragraphs 4 – 5 exist throughout the claims and should be corrected.

Claim Rejections - 35 USC § 103

12. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

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13. Claims 7 – 10, 13, 14, 18 – 24, 26, 29, 30, 32, 35 – 37, 39, 42 – 44, 46, 49 – 51, 53, 56, 57, 58, 60, 63, 64, 69 – 71 and 73 are rejected under 35 U.S.C. 103(a) as being obvious over Mase et al. (USPAT 6236064, Mase) in view of Zhang et al. (USPAT 5403772, Zhang).

Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 a method of manufacturing an insulated gate semiconductor device.

With regard to claim 7, Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 implanting an oxygen ion into a crystal semiconductor comprising a part to become a channel forming region, the crystal semiconductor comprising silicon. Mase does not disclose a method of electron beam to implant the oxygen ion. Mase discloses in figures 5a – 5c, column 5, lines 27 – 67 and column 6, lines 1 – 17 forming a substantially intrinsic region and an oxide region in the part to become the channel forming region by thermally treating the crystal semiconductor comprising silicon at a temperature of 1000 °C to change a region of the crystal semiconductor implanted with the oxygen ion by the implanting step into the oxide region. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 introducing into the crystal semiconductor an impurity that gives one conductivity to form a source region (6) and a drain region (5) in the crystal semiconductor with the channel forming region (7) there between. It is well known in the art to implant an oxygen ion into a crystal semiconductor by electron beam. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use electron beam to implant oxygen ion in order to increase the concentration of ions in the semiconductor crystal. Mase does not teach the substantially intrinsic region has an oxygen concentration below 2×10^{18} atoms/cm³. Zhang teaches in column 9, lines 67 – 68 and column 10, lines 1 – 7 a substantially intrinsic region having an oxygen concentration less than 10^{18} atoms/cm³. It

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would have been obvious to one of ordinary skill in the art at the time of the present invention to use the concentration of impurity of Zhang in the method of Mase in order to obtain a higher mobility as stated by Zhang in column 9, lines 67 – 68 and column 10, lines 1 – 7.

With regard to claim 8, Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 forming a gate insulating film over the part to become the channel forming region after the step of introducing the first impurity. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 forming a gate electrode (4) over the part to become the channel-forming region with the gate insulating film there between.

With regard to claim 9, Mase discloses in column 5, lines 27 – 40 forming a substantially intrinsic region and an impurity region in a part of a crystal semiconductor to become a channel forming region by introducing a first impurity into the impurity region containing oxygen as the first impurity. Mase discloses in figures 5a – 5c introducing into the crystal semiconductor (52) a second impurity that gives one conductivity to form a source region and a drain region (415 and 412) in the crystal semiconductor with the channel forming region (414) therebetween. Mase does not teach the substantially intrinsic region has an oxygen concentration below 2×10^{18} atoms/cm³. Zhang teaches in column 9, lines 67 – 68 and column 10, lines 1 – 7 a substantially intrinsic region having an oxygen concentration less than 10^{18} atoms/cm³. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the concentration of impurity of Zhang in the method of Mase in order to obtain a higher mobility as stated by Zhang in column 9, lines 67 – 68 and column 10, lines 1 – 7. Mase discloses in column 5, lines 27 – 40 that the impurity region occupies only parts of the channel formation region. Mase and Zhang do not disclose what percentage of the width of the channel region is occupied

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by the impurity region. It is well known in the art to have impurity regions that have a total width of W_{pi} in a direction of a width W , and a total of the intervals in W_{pa} in a direction of the width, wherein $W_{pi}/W = 0.1$ to 0.9 and $W_{pa}/W = 0.1$ to 0.9 . It would have been obvious to one of ordinary skill in the art at the time of the present invention to use percentage of the channel regions occupied by the impurity region of 10% to 90% in the method of Mase and Zhang in order to only occupy parts of the channel region so as to increase the carrier mobility of the charier region as stated by Mase in column 5, lines 27 – 40.

With regard to claim 10, Mase discloses in figures 5a – 5c forming a gate insulating film (420) over the part to become the channel forming region inherently after the step of introducing the first impurity. Mase discloses in figures 5a – 5c forming a gate electrode (416) over the part to become the channel forming region with the gate insulating film therebetween.

With regard to claim 13, Mase discloses in column 5, lines 27 – 40 and figures 5a – 5c forming a substantially intrinsic region and a plurality of impurity regions in a part of a crystal semiconductor to become a channel forming region by introducing a first impurity into the impurity regions, the plurality of impurity regions containing oxygen as the first impurity. Mase discloses in figures 5a – 5c introducing into the crystal semiconductor (52) a second impurity that gives one conductivity to form a source region and a drain region (415 and 412) in the crystal semiconductor with the channel forming region (414) there between. Mase discloses in column 5, lines 27 – 40 that the impurity regions occupy only parts of the channel formation region. Mase does not disclose what percentage of the width of the channel region the impurity regions occupy. It is well known in the art to have impurity regions that have a total width of W_{pi} in a direction of a width W , and a total of the intervals in W_{pa} in a direction of the width,

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wherein $W_{pi}/W = 0.1$ to 0.9 and $W_{pa}/W = 0.1$ to 0.9 . It would have been obvious to one of ordinary skill in the art at the time of the present invention to use percentage of the channel regions occupied by the impurity region of 10% to 90% in the method of Mase in order to only occupy parts of the channel region so as to increase the carrier mobility of the charier region as stated by Mase in column 5, lines 27 – 40. It is further obvious in the method of Mase to have impurity regions that alternate with the substantially intrinsic region in a direction of a channel width of the channel forming region in order to have the parts distributed throughout the channel regions as taught by Mase in column 5, lines 27 – 40. Mase does not teach the substantially intrinsic region has an oxygen concentration below 2×10^{18} atoms/cm³. Zhang teaches in column 9, lines 67 – 68 and column 10, lines 1 – 7 a substantially intrinsic region having an oxygen concentration less than 10^{18} atoms/cm³. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the concentration of impurity of Zhang in the method of Mase in order to obtain a higher mobility as stated by Zhang in column 9, lines 67 – 68 and column 10, lines 1 – 7.

Mase discloses in column 5, lines 27 – 40 that the impurity regions occupy only parts of the channel formation region. Mase and Zhang do not disclose what percentage of the width of the channel region the impurity regions occupy. It is well known in the art to have impurity regions that have a total width of W_{pi} in a direction of a width W , and a total of the intervals in W_{pa} in a direction of the width, wherein $W_{pi}/W = 0.1$ to 0.9 and $W_{pa}/W = 0.1$ to 0.9 . It would have been obvious to one of ordinary skill in the art at the time of the present invention to use percentage of the channel regions occupied by the impurity region of 10% to 90% in the method

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of Mase and Zhang in order to only occupy parts of the channel region so as to increase the carrier mobility of the charier region as stated by Mase in column 5, lines 27 – 40.

With regard to claim 14, Mase discloses in figures 5a – 5c forming a gate insulating film over the part to become the channel forming region after the step of forming the plurality of impurity regions. Mase discloses in figures 5a – 5c forming a gate electrode over the part to become the channel forming region with the fate insulating film there between.

With regard to claim 18, Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 forming a source region, a drain region and a channel-forming region using a crystal semiconductor. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 forming a substantially intrinsic region and an impurity region in the channel-forming region. Mase discloses in figures 5a – 5c forming a gate insulating film and a gate electrode over the channel forming region. Mase discloses in column 5, lines 27 – 40 wherein the impurity region formed in the channel forming region pins a depletion layer that expands from the dreain region toward the channel forming region and the source region. Mase discloses in column 5, lines 27 – 40 wherein a carrier moves through the substantially intrinsic region while the carrier avoids the impurity region formed in the part to become the channel forming region. Mase does not teach the substantially intrinsic region has an oxygen concentration below 2×10^{18} atoms/cm³. Zhang teaches in column 9, lines 67 – 68 and column 10, lines 1 – 7 a substantially intrinsic region having an oxygen concentration less than 10^{18} atoms/cm³. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the concentration of impurity of Zhang in the method of Mase in order to obtain a higher mobility as stated by Zhang in column 9, lines 67 – 68 and column 10, lines 1 – 7.

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With regard to claim 19, Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 forming a source region, a drain region and a channel forming region using a crystal semiconductor. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 forming a substantially intrinsic region and an impurity region in the channel forming region. Mase discloses in figures 5a – 5c forming a gate insulating film and a gate electrode over the channel forming region. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 wherein the impurity region controls the threshold voltage to a predetermined value voltage. Mase discloses in column 5, lines 27 – 40 wherein a carrier moves through the substantially intrinsic region while the carrier avoids the impurity region formed in the part to become the channel forming region. Mase does not teach the substantially intrinsic region has an oxygen concentration below 2×10^{18} atoms/cm³. Zhang teaches in column 9, lines 67 – 68 and column 10, lines 1 – 7 a substantially intrinsic region having an oxygen concentration less than 10^{18} atoms/cm³. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the concentration of impurity of Zhang in the method of Mase in order to obtain a higher mobility as stated by Zhang in column 9, lines 67 – 68 and column 10, lines 1 – 7.

With regard to claim 20, Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 forming a source region, a drain region and a channel forming region using a crystal semiconductor. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 forming a substantially intrinsic region and an impurity region in the channel forming region. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 forming a gate insulating film and a gate electrode over the channel forming region. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 discloses wherein an impurity element that expand an energy band width is added to the

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impurity region. Mase does not teach the substantially intrinsic region has an oxygen concentration below 2×10^{18} atoms/cm³. Zhang teaches in column 9, lines 67 – 68 and column 10, lines 1 – 7 a substantially intrinsic region having an oxygen concentration less than 10^{18} atoms/cm³. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the concentration of impurity of Zhang in the method of Mase in order to obtain a higher mobility as stated by Zhang in column 9, lines 67 – 68 and column 10, lines 1 – 7. Mase discloses in column 5, lines 27 – 40 that the impurity region occupies only parts of the channel formation region. Mase and Zhang do not disclose what percentage of the width of the channel region is occupied by the impurity region. It is well known in the art to have impurity regions that have a total width of W_{pi} in a direction of a width W , and a total of the intervals in W_{pa} in a direction of the width, wherein $W_{pi}/W = 0.1$ to 0.9 and $W_{pa}/W = 0.1$ to 0.9 . It would have been obvious to one of ordinary skill in the art at the time of the present invention to use percentage of the channel regions occupied by the impurity region of 10% to 90% in the method of Mase and Zhang in order to only occupy parts of the channel region so as to increase the carrier mobility of the charier region as stated by Mase in column 5, lines 27 – 40.

With regard to claim 21, Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 forming a source region, a drain region and a channel forming region using a crystal semiconductor. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 forming a substantially intrinsic region and an impurity region in the channel forming region. Mase discloses in figures 5a – 5c forming a gate insulating film and a gate electrode over the channel forming region. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 wherein the impurity region pins a depletion layer that expands from the drain region toward the channel

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forming region and the source region. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 wherein an impurity element that expands an energy band width is added to the impurity region. Mase discloses in column 5, lines 27 – 40 wherein a carrier moves through the substantially intrinsic region while the carrier avoids the impurity region formed in the part to become the channel forming region. Mase does not teach the substantially intrinsic region has an oxygen concentration below 2×10^{18} atoms/cm³. Zhang teaches in column 9, lines 67 – 68 and column 10, lines 1 – 7 a substantially intrinsic region having an oxygen concentration less than 10^{18} atoms/cm³. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the concentration of impurity of Zhang in the method of Mase in order to obtain a higher mobility as stated by Zhang in column 9, lines 67 – 68 and column 10, lines 1 – 7.

With regard to claim 22, Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 forming a source region, a drain region and a channel forming region using a crystal semiconductor. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 forming a substantially intrinsic region and an impurity region in the channel forming region. Mase discloses in figures 5a – 5c forming a gate insulating film and a gate electrode over the channel forming region. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 wherein the impurity region controls the threshold voltage to a predetermined value voltage. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 wherein an impurity element that expand an energy band width is added to the impurity region. Mase discloses in column 5, lines 27 – 40 wherein a carrier moves through the substantially intrinsic region while the carrier avoids the impurity region formed in the part to become the channel forming region. Mase does not teach

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the substantially intrinsic region has an oxygen concentration below 2×10^{18} atoms/cm³. Zhang teaches in column 9, lines 67 – 68 and column 10, lines 1 – 7 a substantially intrinsic region having an oxygen concentration less than 10^{18} atoms/cm³. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the concentration of impurity of Zhang in the method of Mase in order to obtain a higher mobility as stated by Zhang in column 9, lines 67 – 68 and column 10, lines 1 – 7.

With regard to claim 23, Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 forming a source region, a drain region and a channel forming region using a crystal semiconductor. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 forming a substantially intrinsic region and an impurity region in the channel forming region. Mase discloses in figures 5a – 5c forming a gate insulating film and a gate electrode over the channel forming region. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 wherein the impurity region has an insulating property. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 wherein an impurity element that expand an energy band width is added to the impurity region. Mase does not teach the substantially intrinsic region has an oxygen concentration below 2×10^{18} atoms/cm³. Zhang teaches in column 9, lines 67 – 68 and column 10, lines 1 – 7 a substantially intrinsic region having an oxygen concentration less than 10^{18} atoms/cm³. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the concentration of impurity of Zhang in the method of Mase in order to obtain a higher mobility as stated by Zhang in column 9, lines 67 – 68 and column 10, lines 1 – 7. Mase discloses in column 5, lines 27 – 40 that the impurity region occupies only parts of the channel formation region. Mase and Zhang do not disclose what percentage of the width of the channel region is

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occupied by the impurity region. It is well known in the art to have impurity regions that have a total width of W_{pi} in a direction of a width W , and a total of the intervals in W_{pa} in a direction of the width, wherein $W_{pi}/W = 0.1$ to 0.9 and $W_{pa}/W = 0.1$ to 0.9 . It would have been obvious to one of ordinary skill in the art at the time of the present invention to use percentage of the channel regions occupied by the impurity region of 10% to 90% in the method of Mase and Zhang in order to only occupy parts of the channel region so as to increase the carrier mobility of the charier region as stated by Mase in column 5, lines 27 – 40.

With regard to claims 24, 30, 37, 44, 51 and 58, it is obvious in the method of Mase and Zhang that a region other than the impurity region within the channel forming region is a substantially intrinsic region.

With regard to claims 26, 32, 39, 46, 53 and 60, it is inherent in the method of Mase wherein at least one section perpendicular to a channel direction of the channel forming region is substantially regarded as an assembly of a plurality of channel forming regions which are sectioned by the impurity regions.

With regard to claims 29, 35, 42, 49, 56 and 63, it is inherent in the method of Mase wherein the impurity regions are in a dot pattern.

With regard to claims 36, 43, 50, 57 and 64, Mase discloses in column 5, lines 27 – 40 wherein the impurity elements are oxygen.

With regard to claims 69 – 71 and 73, Mase and Zhang read on the limitations.

14. Claims 1, 2, and 68 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mase in view of Mukai et al. (USPAT 5585658, Mukai) and Zhang.

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With regard to claim 1, it is inherent in the method of Mase that in order to implant ions into only parts of the channel formation region a mask has to be formed over a crystal semiconductor comprising a part to become a channel forming region. Further it is inherent in the method of Mase that a dotted hole would have to be formed in the mask. Mase discloses in figures 5a – 5c and column 5, lines 27 – 40 forming a substantially intrinsic region and an impurity region in the part to become the channel forming region by introducing a first impurity into the impurity region having the dotted hole, the first impurity being oxygen. Mase also discloses in figures 5a – 5c and column 5, lines 27 – 40 introducing into the crystal semiconductor a second impurity that gives one conductivity to form a source region and a drain region in the crystal semiconductor with the channel forming region therebetween. It is inherent in the method of Mase that the impurity regions are formed through a mask over a crystal semiconductor. Mase does not disclose that the impurity region is formed through a resist mask with a dotted pattern that is patterned by the focused ion beam (FIB) method. Mukai discloses in figures 3a – 3e forming a resist mask (16) and patterning (17) the resist mask by using FIB method (18). It would have been obvious to one of ordinary skill in the art to use the resist and patterning using the FIB method of Mukai in the method of Mase in order to optimally control an impurity profile as discussed by Mukai in column 1, lines 54 – 58. Mase and Mukai do not teach the substantially intrinsic region has an oxygen concentration below 2×10^{18} atoms/cm³. Zhang teaches in column 9, lines 67 – 68 and column 10, lines 1 – 7 a substantially intrinsic region having an oxygen concentration less than 10^{18} atoms/cm³. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the concentration of impurity of Zhang in the method of Mase and Mukai in order to obtain a higher mobility as

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stated by Zhang in column 9, lines 67 – 68 and column 10, lines 1 – 7. Mase discloses in column 5, lines 27 – 40 that the impurity region occupies only parts of the channel formation region. Mase, Mukai, and Zhang do not disclose what percentage of the width of the channel region is occupied by the impurity region. It is well known in the art to have impurity regions that have a total width of W_{pi} in a direction of a width W , and a total of the intervals in W_{pa} in a direction of the width, wherein $W_{pi}/W = 0.1$ to 0.9 and $W_{pa}/W = 0.1$ to 0.9 . It would have been obvious to one of ordinary skill in the art at the time of the present invention to use percentage of the channel regions occupied by the impurity region of 10% to 90% in the method of Mase, Mukai, and Zhang in order to only occupy parts of the channel region so as to increase the carrier mobility of the charier region as stated by Mase in column 5, lines 27 – 40.

With regard to claim 2, Mase discloses in figures 5a – 5c forming a gate insulating film over the part to become the channel forming region after the step of forming the plurality of impurity regions. Mase discloses in figures 5a – 5c forming a gate electrode over the part to become the channel forming region with the fate insulating film therebetween.

With regard to claim 68, Mase and Zhang read on the limitations.

15. Claims 25, 27, 28, 31, 33, 34, 38, 40, 41, 45, 47, 48, 52, 54, 55, 59, 61 and 62 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mase and Zhang as applied to claims 18 – 23 above, respectively, and further in view of one of ordinary skill in the art.

With regard to claims 25, 31, 38, 45, 52 and 59, Mase does not disclose intervals and impurity regions that alternate with the intervals in a direction of a channel width of the channel forming region. It is well known in the art to space regions into intervals wherein there are could

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be 1 to 10 regions and 1 to 10 intervals between the regions in the direction of a channel width, and that would mean that impurity regions can have a total width of W_{pi} in a direction of a width W , and a total of the intervals W_{pa} in a direction of the width, wherein $W_{pi}/W = 0.1$ to 0.9 and $W_{pa}/W = 0.1$ to 0.9 . It would have been obvious to one of ordinary skill in the art at the time of the present invention to use spacing of the intervals in an orderly manner such as 1 to 10 impurity regions and 1 to 10 intervals in the method of Mase in order to have a set pattern which can be formed in a grid like fashion.

With regard to claims 27, 33, 40, 47, 54 and 61, Mase does not disclose intervals and impurity regions that alternate with the intervals in a direction of a channel width of the channel forming region. It is well known in the art to arrange regions at intervals of 100 to 3000 Å. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use spacing of 100 to 3000 Å for the impurity regions of Mase in order for each impurity region to be isolated from each other.

With regard to claims 28, 34, 41, 48, 55, and 62, Mase does not disclose that the crystal semiconductor is a monocrystal semiconductor. It is well known in the art to have a monocrystal semiconductor instead of a polycrystal or amorphous semiconductor. It would have been obvious to one of ordinary skill in the art at the time of the present invention to use a monocrystal semiconductor as the crystal semiconductor in the method of Mase in order to have superior electrical characteristics of the gate electrode.

Allowable Subject Matter

16. Claims 3 – 6, 11 – 12, 15 – 17, 65 – 67, and 72 are allowed.

17. The following is a statement of reasons for the indication of allowable subject matter for claims 15, 16, and 72: The prior art of record does not disclose or suggest, either singularly or in combination, at least the step of forming a plurality of rows comprising dotted impurity regions of oxygen, carbon or nitrogen within a channel forming region of an insulated gate semiconductor device wherein the total distance of the impurity regions along either width equals between 10 % and 90 % of the total respective width.

Response to Arguments

18. Applicant's arguments filed November 4, 2002 have been fully considered but they are not persuasive.

19. With regard to the applicant's arguments that "neither Mase, Mukai, nor Zhang teaches or suggests that said impurity regions..." it should be noted that the claimed invention only stipulates "impurity region" in claims 1, 9, 20 and 23. Therefore, any arguments directed toward impurity regions in these claims are not persuasive, and the rejections are proper.

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20. In response to applicant's argument that "Mase does not suggest that oxygen, carbon, or nitrogen ions are implanted into only parts of the channel formation regions in order to pin a depletion layer", a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. In a claim drawn to a process of making, the intended use must result in a manipulative difference as compared to the prior art. See *In re Casey*, 152 USPQ 235 (CCPA 1967) and *In re Otto*, 136 USPQ 458, 459 (CCPA 1963).

21. In response to applicant's argument that "Mase does not suggest that oxygen, carbon, or nitrogen ions are implanted into only parts of the channel formation regions in order to control the threshold voltage to a predetermined value voltage", a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. In a claim drawn to a process of making, the intended use must result in a manipulative difference as compared to the prior art. See *In re Casey*, 152 USPQ 235 (CCPA 1967) and *In re Otto*, 136 USPQ 458, 459 (CCPA 1963).

22. In response to applicant's argument regarding claim 13 that "the office action fails to point to any motivation to provide these particular claimed relationships", the fact that applicant has recognized another advantage which would flow naturally from following the suggestion of

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the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Paul E Brock II whose telephone number is (703)308-6236. The examiner can normally be reached on 8:30 AM-5:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie Lee can be reached on (703)308-1690. The fax phone numbers for the organization where this application or proceeding is assigned are (703)308-7722 for regular communications and (703)308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703)308-0956.

Paul E Brock II
January 22, 2003



**EDDIE LEE
SUPERVISORY PATENT EXAMINER
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